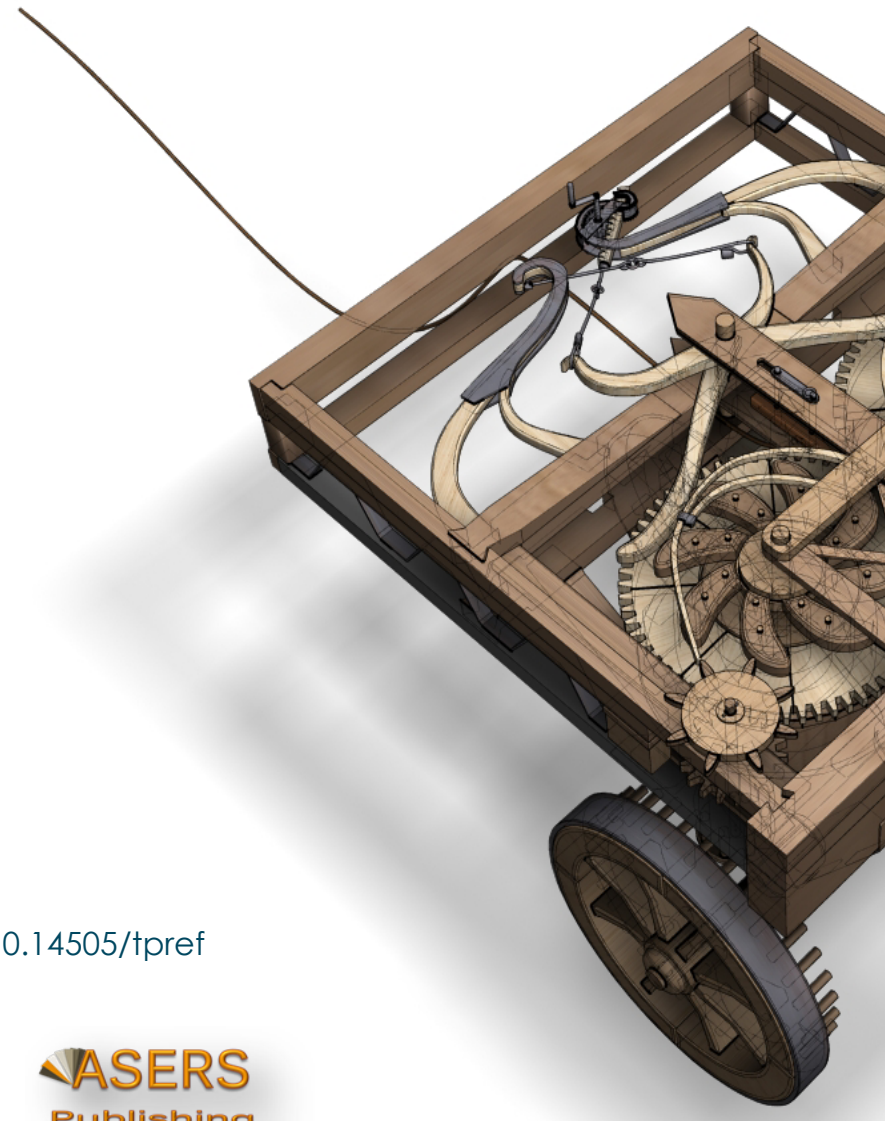
Theoretical and Practical Research in Economic Fields



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Theoretical and Practical Research in Economic Fields

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Nexus between Monetary Indicators and Bitcoin in Selected Sub-Saharan Africa: A Panel ARDL

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Abstract: The rapid adoption and growing prominence of Bitcoin and other cryptocurrencies have sparked significant interest and debate among economists, policymakers, and financial analysts. In Sub-Saharan Africa, where traditional financial systems often face challenges such as limited access to banking services, high transaction costs, and volatile currencies, Bitcoin presents both opportunities and risks. Understanding the interplay between Bitcoin and key monetary indicators such as monetary aggregates, exchange rates, and interest rates can provide valuable insights for policymakers and stakeholders in these economies. This study therefore seeks to investigate the nexus between monetary indicators and Bitcoin in selected Sub-Saharan African countries using a Panel ARDL (Autoregressive Distributed Lag) approach. The analysis focuses on understanding the dynamic relationship between key monetary variables, such as monetary aggregates, exchange rates, interest rates, and Bitcoin prices, from 2010 quarter three to 2022 quarter four. The findings reveal several significant relationships between monetary indicators and Bitcoin across the selected Sub-Saharan African countries. In the short run of the Panel Ardl monetary aggregates exhibit a positive relationship with Bitcoin prices, indicating that changes in the money supply may influence the demand for cryptocurrencies. Conversely, both exchange rates and interest rates show a negative relationship with Bitcoin prices in the short run, suggesting that currency depreciation and higher borrowing costs may reduce demand for Bitcoin. In the long run, the relationship between monetary aggregates and Bitcoin remains positive, emphasizing the potential influence of money supply on cryptocurrency markets over time. However, the significance of exchange rates diminishes, indicating a less pronounced impact in the longer term. Interestingly, interest rates continue to exhibit a significant negative relationship with Bitcoin prices in the long run, highlighting the persistent effect of borrowing costs on cryptocurrency demand. These results have important implications for policymakers, investors, and researchers interested in the intersection of monetary policy and cryptocurrency markets in Sub-Saharan Africa. Policymakers may

consider the impact of monetary policy decisions on cryptocurrency adoption and market dynamics, while investors can use these insights to inform their investment strategies.

Keywords: monetary indicators; interest rate; bitcoin; exchange rate; sub-Saharan Africa.

JEL Classification: E42; G15; C23; R11.

Introduction

Residents of Sub-Saharan Africa are using digital gold as a substitute form of currency. Since growing inflation and debt have plagued many of the region's nations, cryptocurrencies have become an alluring way to save savings, store value, and achieve more financial freedom. One of the most popular coins in cryptocurrency is the bitcoin. Vranken (2017) Since its launch in 2008, the electronic currency known as Bitcoin has grown in popularity. The blockchain a public transaction ledger is a decentralized, peer-to-peer network where transactions in the Bitcoin system are kept. Bitcoin offers decentralized transaction clearing and money issuance. A computationally demanding method for bitcoin mining, which forbids double spending of bitcoins and tampering with confirmed transactions, is essential to the blockchain's integrity. Velde (2013) is of the view that Bitcoins are worthless in and of themselves; their value comes on the belief that they might be accepted by someone else or from government fiat. Though numerous research studies have been done on bitcoin, none used monetary indicators, to see the effect on bitcoin; using panel Ardl. Research such as Vo *et al.* (2021), is of the view that Following its introduction by Nakamoto in 2008 as a substitute online payment method, Bitcoin gained popularity as a research topic and as an attractive investment vehicle. While much research has been done on the price of Bitcoin, relatively little, at least in Information System (IS) research, has been done on how Bitcoin relates to recognized economic metrics. Bitcoin, the pioneering cryptocurrency, represents a paradigm shift in the realm of finance. Its decentralized nature, limited supply, and blockchain technology have disrupted traditional financial systems, offering new avenues for transactions and investments. The growing adoption of Bitcoin globally has prompted a closer examination of its relationship with conventional monetary metrics.

During COVID-19 of 2020, the usage of Bitcoin increased drastically. Koraus *et al.* (2021) stated that in 2020, the association between bitcoin, gold, and the stock market increased due to causes like the worldwide pandemic, financial uncertainty, and the US election. The relentless push for fiat money by governments and central banks to keep their economies afloat in the wake of the coronavirus outbreak caused both bitcoins and gold to rise dramatically in 2020. The cashless Internet economy is drawn to Bitcoin (BTC) as digital gold mostly because of its attributes, which include constant pricing transparency and an absence of limitations, interruptions, or third-party control. Studies have tried to investigate how bitcoin volume is affected. Studies such as Keller and Scholz (2019) analyzed Bitcoin exchange trading and looked at the variables that affect the actions of various kinds of cryptocurrency investors. Market bids are taken into account as investors' offers and orders as a stand-in for their trading behavior to respond to this query. Vaddepalli and Antoney,(2017) also tried to investigate if economic factors are driving bitcoin transactions in selected economies, they made use of key economic factors such as trade openness, inflation, and internet penetration. Bitcoin is indeed increasing worldwide but in less developing countries such as Africa, which depend highly on the developed countries and are still slow in modern facilities. It would be necessary to know how their financial indicators fluctuates with the growing level of cryptocurrency. Levi-Oguike, Sandoval, and Ntagwirumugara, (2019) are of the view that while the developed world makes technological advancements and closes the gaps in current economic, financial, and environmentally "green" systems, improving the socio-economic indices of their respective nations and citizens in the process, it would be wise to reflect on the difficulties facing their third-world counterpart, Africa. The majority of people in the continent do not currently have access to modern, reasonably priced, and dependable energy services, suggesting that the continent continues to face challenges related to energy poverty and access in general.

Monetary indicators form the cornerstone of economic policymaking, influencing factors such as inflation, interest rates, and overall economic stability. In the context of Sub-Saharan Africa, where monetary policies are critical for fostering economic development and stability, understanding the interactions between these traditional indicators and digital assets like Bitcoin is imperative. The rapid adoption of Bitcoin in Sub-Saharan Africa, driven by factors such as limited access to banking services, high remittance costs, and currency volatility, highlights the need for a deeper exploration of its impact on and interaction with local monetary conditions. This study delves into the dynamic relationship between monetary indicators and Bitcoin, a prominent cryptocurrency, across a selection of Sub-Saharan African countries. The utilization of a Panel Autoregressive Distributed Lag (ARDL) framework allows for a comprehensive analysis that incorporates both cross-country variations and time-series

dynamics. The primary objective of this study is to investigate the nexus between monetary indicators and Bitcoin in selected Sub-Saharan African countries. Specifically, we aim to analyze how changes in monetary policies and economic conditions impact the adoption, usage, and valuation of Bitcoin within this region. Selected sub-Saharan African countries were done based on the availability of data. These countries are Nigeria, Kenya, South Africa, cabo verde, Ghana, and Mauritius.

The novelty of this paper lies in its exploration of the dynamic interaction between traditional monetary indicators and Bitcoin in Sub-Saharan African countries, an area that remains relatively underexplored in the existing literature. While many studies focus on Bitcoin's price, trading behavior, or its global impact, this research uniquely examines how monetary policy changes in specific African nations, characterized by inflation, currency volatility, and financial exclusion, affect Bitcoin adoption and usage. By utilizing a Panel ARDL approach across multiple countries, including Nigeria, Kenya, South Africa, Cabo Verde, Ghana, and Mauritius, this study provides valuable insights into the interplay between digital assets and economic conditions in emerging markets.

1. Literature Review

Monetary Indicators

Monetary indicators refer to a set of metrics that reflect the overall health and performance of a country's monetary system. These indicators are closely monitored by policymakers, economists, and financial analysts to assess the effectiveness of monetary policies and to understand the broader economic conditions. This paper will adopt the definition of Curtis and Irvine (2017) for our analysis. Curtis and Irvine (2017) defined monetary indicators to constitute, interest rates, exchange rates, and monetary aggregates. They are of the view that the money supply or the rate at which it is growing is viewed as a policy indicator by the Bank and many economists in addition to interest rates and exchange rates, which are significant indicators of monetary policy. Some propose a money supply monetary policy rule that employs the money supply as a tool for central bank policy. Nominal income determines the demand for nominal money balances.

Bitcoin

Bitcoin is a digital currency that was introduced in 2009 by an anonymous entity or group known as Satoshi Nakamoto. It is often referred to as a cryptocurrency because it relies on cryptographic techniques to secure transactions and control the creation of new units. Unlike traditional currencies issued by governments, Bitcoin operates on a decentralized network called blockchain, which is a public ledger that records all transactions. According to Böhme, *et al.* (2015). Bitcoin is a virtual money that can be used for electronic payments and other internet communication protocols. Engineers created the regulations governing Bitcoin without any apparent input from attorneys or government authorities. The foundation of Bitcoin is a transaction log that is shared by all of the computers in the network. It has safeguards against power concentrations, early adopter adoption via bootstrapping, and incentives for sincere engagement. The architecture of Bitcoin permits public transaction history, a predetermined course for money generation over time, and irreversible transactions.

2. Theoretical Framework

This paper will adopt the quantity theory of money, which was propounded by Friedman (1957). This is because the Quantity Theory of Money posits that changes in the money supply can affect currency values. In the context of Bitcoin, its limited supply and demand dynamics play a significant role in determining its valuation against fiat currencies and other assets. Understanding these valuation mechanisms is crucial for investors and market participants.

Market participants often incorporate Quantity Theory principles into their expectations and investment decisions. Changes in Bitcoin's supply dynamics, such as halving events that reduce block rewards for miners, can influence investor expectations about future scarcity and price movements. the Quantity Theory of Money provides a theoretical lens through which to analyze Bitcoin's monetary characteristics, its impact on economic dynamics, and its potential implications for the broader financial landscape. Incorporating Quantity Theory principles into discussions about Bitcoin enriches our understanding of its role as a digital asset and its interaction with traditional monetary systems. The quantity theory of money is mathematically described as:

$$MV = PT \tag{2.1}$$

Where M is the money supply, V is the velocity of circulation (the number of times money changes hands), P is the average Price level and T is the volume of transactions of goods and services. This theory posits that there is a direct relationship between the supply of money and the price level in an economy. In the context of

Bitcoin, understanding how changes in traditional money supplies (M1, M2, etc.) impact Bitcoin adoption and valuation is crucial. Therefore, equation (2.1) could be modified into:

$$MV = BV \tag{2.2}$$

Where BV is the volume of Bitcoin purchases in the economy. If MV is the money supply used as a monetary indicator in controlling the price level. Then adopting the theory of Curtis and Irvine (2017), interest rate and exchange rate would be added to the monetary aggregate. Therefore, the model would be further modified into:

$$MV + IR + EXR = BV \tag{2.3}$$

Where MV is monetary aggregates, IR is interest rates, EXR is exchange rate and BV is the price of bitcoin.

3. Empirical Review

The fast adoption of Bitcoin in Sub-Saharan Africa, driven by unique economic challenges and opportunities, necessitates a deeper knowledge of its interaction with the traditional monetary policy. This study will investigate the nexus between key monetary variables such as monetary aggregates, exchange rates, and interest rate and Bitcoins in selected Sub-Saharan African countries, employing the Panel Autoregressive Distributed Lag (ARDL) approach. By exploring these interactions, we aim to provide valuable insight for policymakers and stakeholders in the navigating the complexities of integrating digital currencies within these emerging economies. According to Bouri *et al.* 2017, they examine whether Bitcoin can act as a hedge against global uncertainty. Although the study was not specific to the Sub-Saharan context, but it does provide a framework for understanding the relationship between Bitcoins and some vital economic indicators. They employ Quantile regression, and their findings reveal that Bitcoin does act as a hedge against macroeconomic uncertainty as Bitcoin react positively to both higher quantiles and shorter frequency movement of Bitcoin returns.

Hayes (2017) seeks to determine the most likely factors that contribute to the construction of cryptocurrency values, including Bitcoin's worth. The degree of competition in the network of producers, the rate of unit production, and the complexity of the algorithm used to "mine" for the cryptocurrency are the three main factors that influence the value of cryptocurrencies, according to a regression model estimated using cross-sectional empirical data analyzing 66 of the most popular cryptocurrencies. Following a series of stationarity and cointegration tests, Chen (2021) selected the VEC model as the foundation for an empirical price estimate of Bitcoin. He also includes rival approaches on his data set that have been applied in another research. VAR and ADRL models are these approaches. Using daily data from 2009 to 2019, the baseline model demonstrates that, in the near term, the medium of exchange and financial anticipation pressures have the greatest impact on the price of bitcoin, with blockchain technological considerations having the least effect. A thorough empirical analysis of Bitcoin's payment and investing features, as well as how they affect e-commerce, is given by Polasik *et al.* (2015). They look into both adoption and pricing formation since network externality theory contends that a network's worth and uptake are related. They found that the popularity of Bitcoin, the opinions expressed in media articles about cryptocurrencies, and the overall volume of transactions are the main factors influencing its returns. The objective of Havidz, Karman, and Mambea's (2021) analysis is to use liquidity and macrofinancial components as potential influences on the price of Bitcoin. The stock market index, foreign exchange, interest rates, and gold were the macro-financial elements examined in this study; the liquidity ratio was the internal factor. With a total of 2,826 observations collected weekly from 1 January 2017 to 29 December 2019 from 18 nations, this study used a fixed-effect model (FEM) and the Generalized Method of Moments (GMM).

According to the analysis, the US dollar increases the trading of Bitcoin; an increase in interest rates will reduce investors' desire to buy Bitcoin as a speculative asset; and gold may eventually supplant Bitcoin as a preferred asset. Ciaian, Rajčániová, and Kancs (2015) discovered, using daily data spanning five years (2009–2015) and time-series analytical techniques, that the price of BitCoin is significantly influenced by market forces as well as its allure for investors and users, albeit with fluctuations over time. Neves (2020) aims to make a valuable contribution to the analysis of Bitcoin pricing by examining the relationship between the attractiveness and the value of the digital currency. The association between the price of the virtual currency, Bitcoin, and the quantity of Google searches that included the terms bitcoin, bitcoin crash, and bitcoin crisis between December 2012 and February 2018 is examined using the error correction model. The same approach was also used in the study to examine Bitcoin values that were traded during the same period but denominated in various sovereign currencies. The Johansen test shows cointegration between the first two terms' Google search volume and price. Guizani and Nafti (2019) sought to understand the causes of bitcoin fluctuation. Try to determine, examine, and quantify the primary factors that affect the price of bitcoin. They utilize time series analysis on daily data spanning

from December 19, 2011, to February 6, 2018. They employed several strategies, such as the Granger causality test, the cointegration test, and the Auto Regressive Distributed Lag (ARDL) model. According to their predicted results, the price of Bitcoin is significantly influenced by the attractiveness indicator, the number of addresses, and the mining difficulty, with variations over time. Wang, Xue, and Liu (2016) investigate whether digital currencies like bitcoin have the potential to be profitable investments and examine the price variations of bitcoin. Cointegration analysis and the Vector Error Correction (VEC) Model have been used to show how the price of bitcoin relates to several variables, such as the price of oil, the stock market index, and the volume of bitcoin traded daily. The empirical study shows that there is a short-term dynamic relationship and a long-term equilibrium between the four elements. According to the short-term analysis, the stock price index has a comparatively greater impact on the price of bitcoin than the oil price and the volume of bitcoin trades. Kjaerland *et al.* (2018) look for the causes behind the price swings of Bitcoin. The value of the virtual currency Bitcoin has fluctuated, rising from $0 in 2009 to over USD 19,500 in December 2017. Using Ordinary Least Squares regression, they have developed two Autoregressive Distributed Lag models to explain the price changes. 279 weekly measurements from 18.09.2011 to 05.02.2017 are included in the data.

Nine independent factors have been evaluated in this analysis, with the price of Bitcoin serving as the dependent variable. Our primary discovery and contribution is the identification of political events and remarks as major influences on the price of Bitcoin.Kolodin and Fantazzini (2020). examines the connection between hash rate and the price of bitcoin by separating the impact of structural breaks, the halving of the price of bitcoin, and energy efficiency of mining equipment on price trends. To account for any nonlinearity, they either consider the hash rate directly or use the Bitcoin cost-of-production model (CPM) as a proxy for the hash rate. The hash rate and CPMs were never significant in the first subsample under examination (01/08/2016–04/12/2017), however, a significant cointegration relationship was discovered in the second subsample (11/12/2017–24/02/2020). Bouri, Azzi, and Dyhrberg (2017) used a daily database denominated in US dollars to investigate the relationship between price returns and volatility variations in the Bitcoin market. There is no indication of an asymmetric return-volatility link in the Bitcoin market based on the results over the full timeframe. The authors examine whether the return-volatility relationship changed before or after the 2013 price fall. They find that there was a substantial negative relationship between volatility and previous shocks prior to the disaster, but not after. This result demonstrates that, prior to the December 2013 price drop, positive shocks were more likely than negative shocks to raise conditional volatility. Sami and Abdallah's (2022) goal was to evaluate how the cryptocurrency market affected the market value of African enterprises, particularly at the sectoral level. The authors used Panel-Corrected Standard Errors (PCSEs) and Panel Double-Clustered Standard Errors (PDCSEs) to achieve the primary objective of the study. The outcome demonstrates how the bitcoin market lowers a company's worth in Africa. Bouraoui (2020) examined the volume of local Bitcoin transactions in 21 developing nations. Specifically, he aims to identify the factors that influenced the amount of Bitcoin trading in these nations between August 1, 2015, and June 2, 2018. He discovered evidence of a strong correlation, particularly in the near term, between the local Bitcoin trade volume in each nation and the corresponding banking system access based on VECM and ARDL models. Ozili (2022) demonstrated the merits and benefits of decentralized financing (DEFI) using literature reviews and external data sources. The results indicate that DeFi is not well-liked in Africa. Ma *et al.* (2022). Investigated monetary policy shocks and bitcoin prices, they investigated this using FOMC meetings announcements in the USA, concerning monetary policy. They had three strands of results based on the announcement effect. Though using an empirical quantile regression analysis, they found that the effect of bitcoin prices from monetary policy is more pronounced in the higher quantile, which shows that monetary policy greatly impacts bitcoin prices in the bull market. Zhang, Hou, and Ba (2021) used a special database from the Decentralized Finance platform to examine the factors influencing interest rates in the cryptocurrency loan market. Using a moderated mediation model, they verify the presence of both moderation and mediation effects in the bitcoin loan market. First, the empirical findings demonstrate a strong correlation between the interest rate and the loan-to-value ratio, which serves as the lending industry's mediation variable. Secondly, there is an obvious correlation between the interest rate and changes in the price of Bitcoin. Feng and Zhang (2023) employed the Autoregressive Distributive Lag (ARDL) and Error Correction Specification in analyzing the currency exchange rate predictability, emphasizing the new power of bitcoin prices. They found out that exchange rate serves as a fundamental for bitcoin prices. Troian (2024) investigates the complex relationship between oil futures and cryptocurrencies from 2018 to 2024, identifying weak short-term correlations but significant long-term cointegration, especially involving major cryptocurrencies like Bitcoin and Ethereum. The study highlights heterogeneous relationships across cryptocurrency-oil pairs and shows limited predictive power of oil prices on cryptocurrency movements. These findings offer important insights for portfolio diversification, risk management,

and market regulation, contributing to the growing literature on the integration of digital assets with traditional financial markets. Setyawan *et al.* (2024) explore cryptocurrency's role in emerging markets, highlighting its benefits lower transaction costs, faster settlements, and increased transparency while addressing challenges like regulatory hurdles, security concerns, and limited awareness. The study examines cryptocurrency's disruption of traditional financial systems and its potential in international trade, offering insights for policymakers, businesses, and investors.

This paper seeks to address the significant gap in the literature by focusing on the interaction between monetary indicators and Bitcoins in Sub-Saharan Africa. The Sub-Saharan region encompasses diverse economies with varying levels of development, regulatory environments and financial infrastructures. By investigating how these factors influence the relationship between monetary indicators and Bitcoins. This study provides valuable insights for policymakers. Exploring the policy implications such as how central banks view and interact the Bitcoin-related activities and the risk management strategies adopted by the financial institutions and governments in response to the growing presence of Bitcoins adds substantial value to the body of knowledge on the Bitcoin relationship to monetary policy in the selected countries

4. Materials and Methods

The study used the Panel Autoregressive distributive lag model approach to quantify the link between monetary indicators and bitcoin in selected sub-Saharan African countries. Bloomberg and International Financial Statistics provided the data for this study. Quarterly data from 2010 quarter three to 2022 quarter four was included in the study. The study period chosen for this purpose is based on the availability of data, and it covered the early period of Bitcoin and its boom era. Table 1 displays the lists of variables for which study data were collected. It explains the several variables and resources utilized to estimate the monetary indicator and bitcoin in sub-Saharan Africa.

Table 1. Data and Variable Description.

Variables	Description	Source
BV	Bitcoin is viewed as a digital alternative investment in Sub-Saharan Africa, allowing individuals and institutions to diversify their investment portfolios beyond traditional assets like stocks, bonds, and real estate.	Bloomberg
MV	Monetary aggregates of selected sub-Saharan African countries. In the context of this paper, it is the highest monetary aggregate in each sub-Saharan Africa used.	International Financial Statistics
Ir	The interest rate of selected sub-Saharan African countries. In the context of this paper, interest. Interest rates in Sub-Saharan Africa, as in other regions, are a critical tool of monetary policy used by central banks to influence economic activity. They represent the cost of borrowing money or the reward for saving.	International Financial Statistics
exr	Exchange rate of selected sub-Saharan African countries. The exchange rate is a critical economic variable that denotes the value of one country's currency in terms of another currency. In Sub-Saharan Africa, exchange rates hold significant importance due to the region's economic characteristics and the role of international trade, investment, and aid in these economies.	International Financial Statistics

Source: Authors computation, 2024

5. Model Specification

This study employs quarterly series data of the selected monetary indicators of 6 sub-Saharan countries from 2010 quarter three to 2022 quarter four. The series was procured from Bloomberg and international financial statistics. The variable of interest includes bitcoin (BV), monetary aggregate [MV], interest rate [Ir], and exchange rate (exr).

Mean Group

To address the bias resulting from heterogeneous slopes in dynamic panels, Pesaran, Shin, and Smith (1995) proposed the Mean Group (MG) model. The MG estimator, on the other hand, calculates the panel's long-run parameters by averaging the long-run parameters from ARDL models for each country. If the ARDL model, for example,

$$y_t = a_i + \gamma_i y_{i,t-1} + \beta_i x_{it} + \varepsilon_{it} \quad (5.1)$$

Here, i stands the country where i=1,2,3…N. Then the long run parameter is θ_i

$$\theta_i = \frac{\beta_i}{1-\gamma_i} \quad (5.2)$$

The MG estimator for the whole panel is given by

$$\theta = \frac{1}{N}\sum_{i=1}^{N}\theta_i \quad (5.3)$$

$$\sigma = \frac{1}{N}\sum_{i=1}^{N}\sigma_i \quad (5.4)$$

Equations (5.2) to (5.4) illustrate how the model estimates distinct regressions for every nation and computes the coefficients as an unweighted average of the predicted coefficients for each nation. There are no limitations as a result. It permits heterogeneity and variation in all coefficients over both the short run and long run. However, having a sizable enough time-series dimension in the data is a prerequisite for this method to work consistently and be valid. Conversely, the Pool Mean Group was utilized to identify both the short- and long-term relationships between bitcoin and monetary indicators, as well as to look into potential country-specific heterogeneous dynamics. The best method for analyzing dynamic panels is ARDL (p,q) model with autoregressive distributed lag in error correction form then after that, compute the model using the mean group (MG) that Pesaran and Smith(1995) provided and the estimators for the Pooled Mean Group (PMG) created by Pesaran *et al.* (1999). The ARDL according to Loayza and Ranciere (2006), the specification is written as follows:

$$Y_{it} = \sum_{j=1}^{p-1}\gamma_y^i\,(y_i)_{t-j} + \sum_{j=0}^{q-1}\partial_y^i\,(x_i)_{t-j} + \varphi^i(y_i)_{t-j} + \mu_i + \varepsilon_{it} \quad (5.5)$$

where $(x_i)_{t-j}$the (k x 1) is a vector of explanatory variables for group i and μ_i represents the fixed effect. The panel may not be balanced in theory, and p and q may differ between nations. One way to reparametrize this model is as a VECM system:

$$\Delta Y_{it} = \theta_i\left(Y_{i,t-1} - \beta_i x_{i,t-1}\right) + \sum_{j=1}^{p-1}\gamma_y^i\,\Delta Y_{i,t-1} + \sum_{j=0}^{q-1}\delta_y^i\Delta(x_i)_{t-j} + \mu_i + \varepsilon_{it} \quad (5.6)$$

In this case, the equilibrium (or error)-correction parameters are denoted by the θ_i; and the long-run parameters by the β_i. The elements β are shared by all countries, which is the pooled mean group restriction.

$$\Delta y_{it} = \theta_i\left(y_{i,t-1} - \beta_i x_{i,t-1}\right) + \sum_{j=1}^{p-1}\gamma_y^i\,\Delta(y_i)_{t-j} + \sum_{j=0}^{q-1}\delta_y^i\Delta(x_i)_{t-j} + \mu_i + \varepsilon_{it} \quad (5.7)$$

where y is Bitcoin, x is a set of independent variables, γ, and δ represent the short-run coefficients of dependent and independent variables respectively, β is the long-run coefficients, θ is the coefficient of speed of adjustment to the long-run status. In contrast, i and t represent the country and time respectively. According to Demetriades and Law (2006), the three models that can be used to estimate the above specification are PMG, MG, and even DFE estimators. All three models take into account the heterogeneity of the dynamic adjustment process and the long-run equilibrium.

Hausman Test

The Hausman test is a statistical test used in econometrics to determine whether the Pooled mean group or Dynamic fixed effect is more appropriate in panel data analysis. In the context of panel ARDL (Auto Regressive Distributed Lag) models, which are used to analyze the long-run relationships among variables in panel data, the Hausman test helps in choosing between dynamic fixed effects and pooled mean group.

6. Results and Discussions

Descriptive Statistics

Table 2. Summary Statistics of the Variables used in this Study

Variables	BV	MV	Ir	exr
Mean	8430.69	5688769	8.64	120.56
Maximum	58960.2	5.22e+07	26	612.19
Minimum	0.06	11155.98	0.25	2.23
Standard dev.	14137	1.07e+07	5.72	136.07
Observation	300	300	300	300
Time series	50	50	50	50
Country	6	6	6	6

Source: Authors computation, 2024

The descriptive statistics presented in Table 2, show that MV has the highest mean value among the variables, followed by BV. The variable with the highest maximum value is BV with a value of 58960.2, followed by exr, and the variable with the least maximum value is MV with a value of 5.22e+07. The variables with the minimum value is BV, with a value of 0.06. The standard deviation of BV, MV and Ir are less than their mean except exr which their standard deviation is greater than their mean. This means that the variables in the panel not dispersed from their mean, except exr which is volatile.

Unit Root Test

The panel unit root aspect of the Harris tzavalis test is used when dealing with panel data, which involves observations on multiple individuals or entities over time. It extends the unit root test to account for potential cross-sectional dependence among the individuals in the panel. This is important because it allows for a more accurate analysis of the data by considering both the time series and cross –sectional dimensions.

Table 3. The Unit Root Test

Variables	level		first difference	
	Statistics	z	statistics	z
BV	0.83***	-3.46		
lnMV	0.99	1.89	-0.24***	-45.78
Ir	0.91*	-1.42		
exr	1.00	2.51	0.06***	-34.23

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors Computation (2024).

The table shows that BV and ir are stationary at level, BV at 1percent and Ir at 10 percent level of significance. MV and exr were stationary at first difference, both at 1 percent level of significance

Panel ARDL Model

The Panel Autoregressive Distributed Lag (Panel ARDL) approach is a statistical method that analyzes relationships between variables in panel data settings. It combines the Autoregressive Distributed Lag (ARDL) model with panel data techniques to account for the analysis's time series and cross-sectional dimensions.

The result of the short-run from Table 4, shows that dynamic fixed effect (DFE) is preferable to the pooled mean group. Based on the result of the Hausman test it shows that the Dynamic Fixed Effect should be chosen over the Pool Mean Group model. The reason for this choice is that the Hausman test indicates a statically significant difference between PMG and DFE estimates suggesting that the DFE model which is consistent under both the null and alternative hypothesis provides a more reliable estimate, Also the DFE model can handle the problem of potential endogeneity of omitted variable biases more effectively than the PGM model. The result of the DFE, shows that 21% of deviation are corrected each quarter. This indicates a high speed of adjustment towards the equilibrium of in the Bitcoin market, suggesting that Bitcoin prices are responsive to shifts in economic fundamentals. A change in MV in selected African countries would bring about a 14943 positive unit change in BV. A change in Ir in sub-Saharan Africa would bring about a 920.13 unit reduction in BV, which showed to be significant at 5% level of significance. On the other hand, a change in exr in sub-Saharan Africa brings about a 15.82 reduction on BV.

The long-run of DFE shows that a change in MV, would bring about a 0.0027 positive unit change on BV, which showed to be significant at 10 %. A change in Ir, would bring about a 2376.95-unit decrease in BV, which showed to be significant at 1% level of significance. The result of the exr, showed that a 1perccent change in exr would bring about a 113.63-unit reduction in BV which is not significant. The constant showed that BV would have a unit decrease of 5737.39, which is also significant at 5%.

Table 4. Panel ARDL Model

	Pool Mean Group Model (PGM)		Dynamic Fixed Effect Model (DFE)	
VARIABLES	Long Run	Short Run	Long Run	Short Run
Error Correction		0.25***		0.21***
		(0.0818)		(0.0369)
D.lnMV		17,150		14,943
		(18,730)		(14,045)
D.ir		-1,715		-920.1**
		(1,059)		(445)
D.exr		-56.42		-15.82
		(259.7)		(45.46)
M3	-0.0048		0.0027*	
	(0.0041)		(0.0015)	
Ir	-1,381*		-2,377***	
	(720.3)		(887.6)	
exr	2,137***		-113.6	
	(367.6)		(127.7)	
Constant		29,361*		-5,737**
		(15,310)		(2,438)
Observations	294	294	.	.
HausmanTest[Chi-Square]				41.85***

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Authors Computation (2024).

Discussion of findings

The findings highlight the intricate relationship between monetary indicators and Bitcoin valuation in Sub-Saharan Africa. The significant positive impact of money velocity suggests that economic activity can have a favorable effect on Bitcoin demand. Conversely, the significant negative impact of interest rates reinforces the sensitivity of Bitcoin to traditional monetary policy tools, where higher rates discourage investment in non-yielding assets. The non-significant impact of exchange rates indicates a complex and less clear-cut relationship, warranting further investigation.

The significant positive impact of money velocity on Bitcoin valuation suggests that as economic activity increases, the demand for Bitcoin also rises. This conforms to Ma *et al.* (2022), and it could be due to several factors, including increased disposable income leading to more investment in cryptocurrencies, or a greater propensity for people to seek alternative investments during times of economic dynamism. The significant negative impact of interest rates on Bitcoin valuation indicates that higher interest rates discourage investment in Bitcoin. This does not conform to Zhang, Hou, and Ba (2021) who concluded that there is a correlation between interest rate and bitcoin. This could be that Bitcoin, like other non-yielding assets, does not provide interest or dividends. When traditional financial instruments offer higher returns due to increased interest rates and are less volatile in sub-Saharan Africa, investors may prefer these over Bitcoin, leading to a decrease in Bitcoin demand in Sub-Saharan Africa. The non-significant impact of exchange rates on Bitcoin valuation suggests that the relationship between exchange rates and Bitcoin demand is complex and not straightforward. This contradicts the works of Feng and Zhang (2023), it could be due to the decentralized nature of Bitcoin, making it less sensitive to currency fluctuations, or because other factors, such as regulatory environments and investor sentiment, play a more dominant role in influencing Bitcoin demand in Sub-Saharan Africa. Further investigation is needed to understand the underlying dynamics.

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Conclusion and Recommendations

The study made use of monetary indicators comprising monetary aggregates, interest rates, and exchange rates of selected sub-Saharan countries. The dependent variable in the analysis is bitcoin volume. The descriptive statistics and unit root were the pre-estimation tests carried out. The panel Ardl was then estimated using the pooled mean group and dynamic fixed effect based on Stata 17. The unit root test result showed that the series were of mixed stationarity. The Hausman test showed that the dynamic fixed effect is preferable to the pooled mean group. The result of the dynamic fixed effect of the panel ardl showed that in the short run monetary aggregates have a positive relationship with Bitcoin while the exchange rate and the interest rate have a negative relationship. The same result was found in the long run, though in the short run, interest rate and monetary aggregates was significant but in the long run, only the exchange rate was insignificant. Interest rate and monetary aggregate showed to be significant both in the short run and long run. Based on this findings, there is a relationship between monetary indicators and Bitcoin in sub-Saharan Africa.

1. Africa should strive to provide clear and comprehensive regulations regarding cryptocurrencies like Bitcoin. This includes defining legal status, taxation policies, and regulatory oversight to ensure investor protection and financial stability. Policymakers (monetary- fiscal consolidation) may consider the impact of monetary policy decisions on cryptocurrency adoption and market dynamics, while investors can use these insights to inform their investment strategies. Furthermore, researchers can build upon these findings to explore additional factors shaping the relationship between monetary indicators and Bitcoin in the region.
2. Given the positive relationship between monetary aggregates and Bitcoin in the short and long run, central banks could consider adjusting their monetary policy to manage the impact on Bitcoin prices. This might involve monitoring and possibly adjusting money supply growth rates to moderate fluctuations in Bitcoin prices.
3. While the exchange rate was not significant in the long run, it had a negative relationship with Bitcoin in the short run. Central banks should continue to monitor exchange rate movements and their impact on Bitcoin prices, as sudden changes in exchange rates could influence investor behavior towards Bitcoin.

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Credit Authorship Contribution Statement

Authors have contributed equally to this research.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have used/not used generative AI and AI-assisted technologies during the preparation of this work.

References

[1] Böhme, R., Christin, N., Edelman, B., and Moore, T. (2015). Bitcoin: Economics, Technology, and Governance. *the Journal of Economic Perspectives*, *29*(2): 213–238. DOI:https://doi.org/10.1257/jep.29.2.213

[2] Bouraoui, T. (2020). The drivers of Bitcoin trading volume in selected emerging countries. *the Quarterly Review of Economics and Finance*, *76:* 218–229. DOI: https://doi.org/10.1016/j.qref.2019.07.003

[3] Bouri, E., Azzi, G., and Dyhrberg, A. H. (2017). On the return-volatility relationship in the Bitcoin market around the price crash of 2013. *Economics Journal Articles*, 11(1). DOI: https://doi.org/10.5018/economics-ejournal.ja.2017-2

[4] Bouri, E., Gupta, R., Tiwari, A. K., and Roubaud, D. (2017). Does Bitcoin hedge global uncertainty? Evidence from wavelet-based quantile-in-quantile regressions. Finance Research Letters. DOI:https://doi.org/10.1016/j.frl.2017.02.009

[5] Chen, Y. (2021). Empirical analysis of bitcoin price. *Journal of Economics and Finance*, *45*(4): 692–715. DOI:https://doi.org/10.1007/s12197-021-09549-5

[6] Ciaian, P., Rajčániová, M., and Kancs, D. (2015). The economics of BitCoin price formation. *Applied Economics*, *48*(19): 1799–1815. DOI: https://doi.org/10.1080/00036846.2015.1109038

[7] Curtis, D., and Irvine, I. (2017). *Principles of macroeconomics* [Ocr_module_version]. Lyryx.

[8] Demetriades, P., and Hook, L. S. (2006). Finance, Institutions and Economic Development. *International Journal of Finance and Economics*, 11(3): 245-260.

[9] Dyhrberg, A.H. (2016) Hedging Capabilities of Bitcoin. Is It the Virtual Gold? Finance Research Letters, 16, 139-144. DOI: https://doi.org/10.1016/j.frl.2015.10.025

[10] Fantazzini, D., and Kolodin, N. (2020). Does the hashrate affect the bitcoin price? *Journal of Risk and Financial Management*, *13*(11): 263. DOI: https://doi.org/10.3390/jrfm13110263

[11] Feng, W., and Zhang, Z. (2023). Currency exchange rate predictability: The new power of Bitcoin prices. *Journal of International Money and Finance*, *132*: 102811. https://doi.org/10.1016/j.jimonfin.2023.102811

[12] Friedman, M. (1957). Studies in the quantity theory of money. *Southern Economic Journal*, *24*(1): 93. DOI:https://doi.org/10.2307/1053651

[13] Guizani, S., and Nafti, I. K. (2019). The Determinants of Bitcoin price Volatility: An investigation with ARDL model. *Procedia Computer Science*, *164*: 233–238. DOI: https://doi.org/10.1016/j.procs.2019.12.177

[14] Havidz, S. a. H., Karman, V. E., and Mambea, I. Y. (2021). Is bitcoin price driven by macro-financial factors and liquidity? A Global Consumer Survey Empirical study. *Organizations and Markets in Emerging Economies*, 12(2): 399–414. DOI: https://doi.org/10.15388/omee.2021.12.62

[15] Hayes, A. (2017). Cryptocurrency value formation: An empirical study leading to a cost of production model for valuing bitcoin. *Telematics and Informatics*, *34*(7): 1308–1321. DOI:https://doi.org/10.1016/j.tele.2016.05.005

[16] Keller, A. and Scholz, M. (2019) Trading on Cryptocurrency Markets: Analyzing the Behavior of Bitcoin Investors. *ICIS 2019 Proceedings*. 11. Available at: https://aisel.aisnet.org/icis2019/blockchain_fintech/blockchain_fintech/11

[17] Kjærland, F., Meland, M., Oust, A., and Øyen, V. (2018). *How can Bitcoin Price Fluctuations be Explained?* Available at: http://hdl.handle.net/11250/2500190

[18] Korauš, A. *et al.* (2021). Bitcoin price as one of basic cryptocurrencies in relation to the basic stock market's indicators, *Entrepreneurship and Sustainability Issues*, 9(2): 552-569. DOI:https://doi.org/10.9770/jesi.2021.9.2(36)

[19] Levi-Oguike, J., Sandoval, D., and Ntagwirumugara, E. (2019). Blockchain technology and renewable energy access: a case for sub-Saharan Africa. *2019 IEEE 5th International Conference for Convergence in Technology (I2CT),* Bombay, India. DOI: https://doi.org/10.1109/i2ct45611.2019.9033952

[20] Loayza, N.V. and Rancière, R. (2006). Financial Development, Financial Fragility, and Growth. *Journal of Money, Credit and Banking*, 38(4): 1051-1076.

[21] Ma, C., Tian, Y., Hsiao, S., and Deng, L. (2022). Monetary policy shocks and Bitcoin prices. *Research in International Business and Finance*, *62*, 101711. DOI: https://doi.org/10.1016/j.ribaf.2022.101711

[22] Neves, R. H. D. (2020). Bitcoin pricing: impact of attractiveness variables. *Financial Innovation*, *6*(1). DOI:https://doi.org/10.1186/s40854-020-00176-3

[23] Ozili, P. K. (2022). Decentralised finance and cryptocurrency activity in Africa. In *Contemporary studies in economic and financial analysis* (pp. 3–11). DOI: https://doi.org/10.1108/s1569-37592022000109a001

[24] Pesaran, M.H., and Smith, R. (1995). New Directions in Applied Macroeconomic Modeling. Dept. of Applied Economics, University of Cambridge.

[25] Pesaran, M.H., Shin, Y. and Smith, R.P. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. *Journal of the American Statistical Association*, 94(446): 621-634.

[26] Polasik, M., Piotrowska, A., Wisniewski, T. P., Kotkowski, R., and Lightfoot, G. (2015). Price fluctuations and the use of Bitcoin: An empirical inquiry. *International Journal of Electronic Commerce*, *20*(1): 9–49. DOI:https://doi.org/10.1080/10864415.2016.1061413

[27] Sami, M., and Abdallah, W. (2022). Does cryptocurrency hurt African firms? *Risks*, *10*(3), 53. DOI: https://doi.org/10.3390/risks10030053

[28] Setyawan, A. A., Winotoatmojo, H. P., and Ananda, N. K. P. (2024). "Cryptocurrency and Financial Inclusion: Bridging the Gap in Emerging Countries." *Dinasti International Journal of Economics, Finance and Accounting*, 5(2). DOI: https://doi.org/10.38035/dijefa.v5i2.2554

[29] Troian, K. (2024). Analysing the Relationship Between Oil Futures and Cryptocurrency Markets From 2018 to 2024. *International Journal of Economics, Commerce and Management*, 12(7): 304-328.

[30] Vaddepalli, S., and Antoney, L. (2017). Are economic factors driving BitCoin transactions? An analysis of select economies. *Journal of Emerging Issues in Economics, Finance and Banking (JEIEFB)*, 2215–2227.

[31] Velde, F. R. (2013). Bitcoin: A Primer. *Chicag O Fed Letter*. Available at: https://EconPapers.repec.org/RePEc:fip:fedhle:y:2013:i:dec:n:317

[32] Vo, A., Chapman, T. A., and Lee, Y. (2021). Examining Bitcoin and Economic Determinants: An Evolutionary perspective. *the Journal of Computer Information Systems*, *62*(3): 572–586. DOI:https://doi.org/10.1080/08874417.2020.1865851

[33] Vranken, H. (2017). Sustainability of bitcoin and blockchains. *Current Opinion in Environmental Sustainability*, *28*: 1–9. DOI: https://doi.org/10.1016/j.cosust.2017.04.011

[34] Wang, J., Xue, Y., and Liu, M. (2016). An analysis of Bitcoin price based on VEC model. *Atlantis Press*. DOI:https://doi.org/10.2991/icemi-16.2016.36

[35] Zhang, S., Hou, X., and Ba, S. (2021). What determines interest rates for bitcoin lending? *Research in International Business and Finance*, *58*, 101443. DOI: https://doi.org/10.1016/j.ribaf.2021.101443

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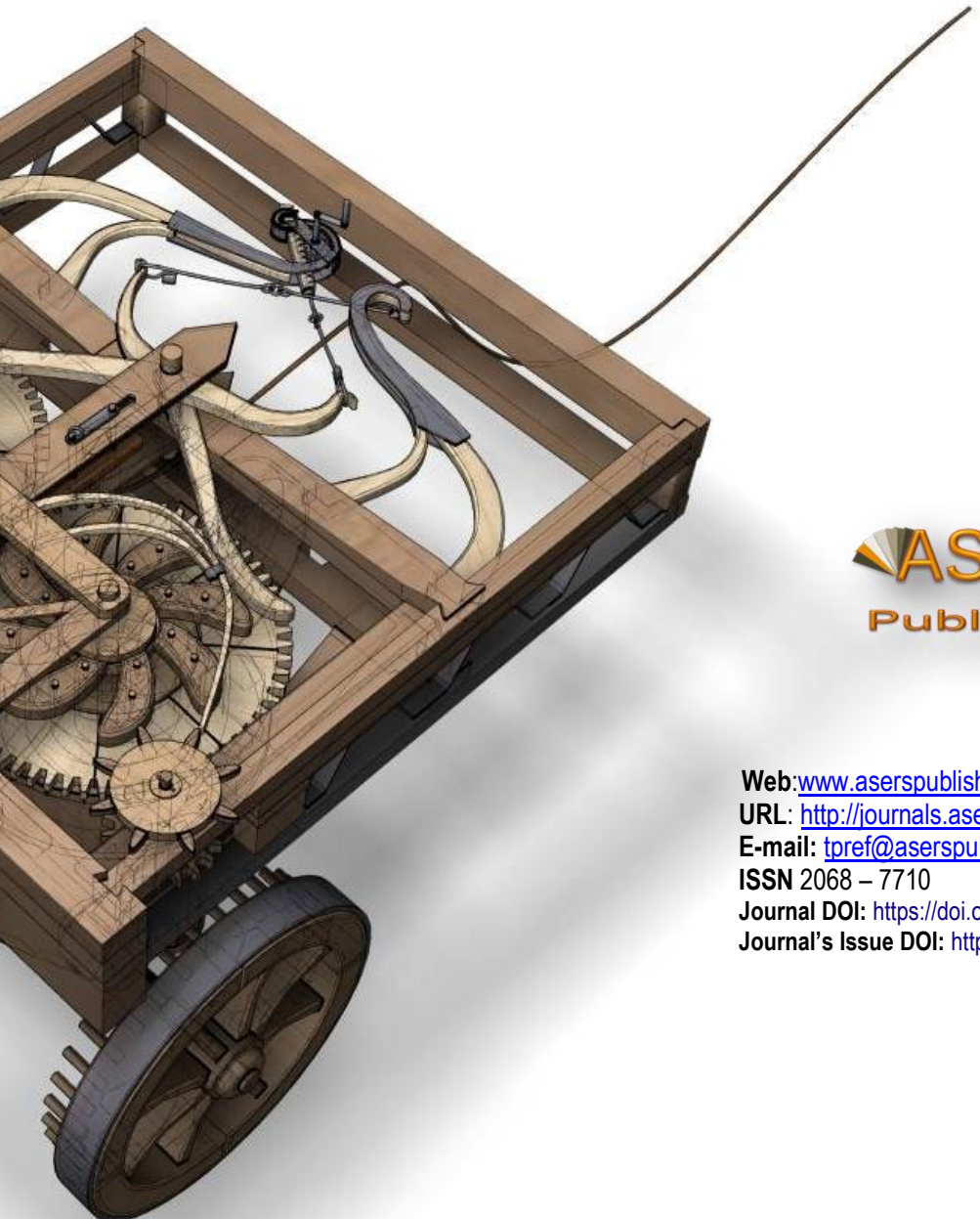

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